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UNITED STATES DEPARTMENT OF AGRICULTURE

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THE CHINESE JUJUBE.

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With a chapter on

"THE COMPOSITION OF THE CHINESE JUJUBE."

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INTRODUCTION.

The Chinese explorations conducted by the United States Department of Agriculture have resulted in the introduction of many new and valuable plants. One of the more promising commercial possibilities resulting from these introductions is the jujube, tsao, or Chinese date, *Ziziphus jujuba* Mill. The scions of the first large-fruited varieties to be established in the United States were collected by the late Frank N. Meyer, agricultural explorer, in 1908, at Tsingtze, Shansi, China. The fruiting of these varieties in America stimulated interest in this excellent fruit, and since that time there has been an ever-increasing demand for plants of the more desirable varieties and for information concerning them.

The jujube is well adapted to cultivation in a large portion of the southern and western United States, since it grows well in the drier sections or where alkali is present in the soil in sufficient quantities

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to retard the development of many of our common fruits. It has a distinct advantage over most of the deciduous fruits now grown in that section, because it flowers so late that it is rarely injured by spring frosts.

The jujube has a high food value. Chemical analyses have shown that it compares very favorably with both dates and figs. When properly processed by cooking in a sugar sirup and afterwards dried, it becomes a delicious confection, superior to many fruit confections now on the market. The fresh fruit can be successfully used in the home for sweet pickles, fruit butter, preserves, and as a stewed fruit, in addition to its use as a confection. The dried fruit can be used in breads, cakes, puddings, and with cooked cereals.

THE CHINESE JUJUBE IN ASIA AND EUROPE.

The Chinese jujube was cultivated in northern China many centuries before the beginning of the Christian era. A Chinese work, Pen Tsao Kang Mu, published 300 years ago by Li Shi Chen, listed 43 named varieties; hundreds are described in the more recent works. It is now widely distributed, extending from northern and central China through northern India, Persia, Armenia, and Syria to the Mediterranean region, Spain, and France. Throughout most of this region, according to De Candolle (*2*),[1] the jujube is found both wild and cultivated. It was introduced into these countries several hundred years ago.

No name is found for the Chinese jujube in the Sanskrit or Hebrew languages, and it is not mentioned in the works of the ancient Greeks, an indication that it is not a native of western Asia. In summarizing, De Candolle says—

> It appears to me probable, therefore, that the species is a native of the north of China; and it was introduced and became naturalized in the west of Asia after the epoch of the Sanskrit language, perhaps 2,500 or 3,000 years ago; that the Greeks and Romans became acquainted with it at the beginning of our era, and that the latter carried it to Barbary and Spain, where it became partially naturalized by the effect of civilization.

According to Pliny (*11*) the Chinese jujube was introduced into Rome from Syria by the consul Sextus Papinius near the end of the reign of Augustus.

Although grown for hundreds of years in China, the jujube was long obscure in western Europe. There are few references to it in early botanical or horticultural literature. Since its introduction into the Mediterranean region it has become better known, and all the more important dictionaries and works on gardening in Europe contain accounts of it.

The varieties known and sold in the markets of Europe are seedlings, the fruits of which are about the size of an olive and would probably never attract much attention in the American markets. European horticulturists appear never to have investigated the possibilities of the Chinese jujube.

Meyer's explorations have shown that there are hundreds of varieties of this valuable fruit in China, varying in size from that of a cherry to 2 inches or more in diameter.

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[1] Serial numbers (*italic*) in parentheses refer to "Literature cited," at the end of this bulletin.

THE CHINESE JUJUBE IN THE UNITED STATES.

Long before Meyer sent to this country the improved large-fruited varieties from China, there had been numerous introductions into the United States of seedling varieties of jujube. These introductions go back even beyond the date of the establishment of the Department of Agriculture. In a portion of the report of the Commissioner of Patents relating to agriculture for the year 1855 (*4*), there is an extract from the correspondence of Robert Chisolm, of Beaufort, S. C.: "In 1837," he writes, "while traveling in the south of Europe, I was induced to purchase some plants of the jujube, which I have cultivated ever since, and as this shrub suckers freely I have considerably increased my stock, though to nothing like the extent I might have done had I been disposed."

Mr. Chisolm, in a letter to the Southern Cultivator dated July 29, 1851 (*3*), recommended the jujube to southern gardeners and planters, remarking: "I could send some of the seeds by mail to persons applying soon, in quantities proportioned to the number of applicants."

The Patent Office distributed seeds of the jujube in 1854 (*1*), principally in the Middle and Southern States. In the Agricultural Report for 1858 (*12*) we find "the jujube is just now beginning to be freely introduced into our nurseries and gardens." The nursery catalogue of P. J. Berckmans, of Augusta, Ga., for 1861, lists the jujube.

As an ornamental and hedge plant it attracted a good deal of interest during the seventies, as is shown by the literature of that time and the existence to-day in the Southern States of many trees 40 to 50 years old. These trees were grown in Florida, Georgia, South Carolina, Louisiana, Mississippi, Texas, and the District of Columbia, and as far north as Germantown, Pa. Around Charleston, S. C., there are a number of old trees, and natives of the city now 50 to 60 years of age can remember eating the fruit when they were children. In Washington, D. C., in the grounds of the Department of Agriculture, there is a jujube tree which was placed there in 1868. The jujube was introduced into California in 1876 by G. P. Rixford, at present of the Office of Crop Physiology and Breeding Investigations of the Bureau of Plant Industry, United States Department of Agriculture.

From 1897 to 1908 the Department of Agriculture, through the Office of Foreign Seed and Plant Introduction, received numerous shipments of jujube seeds from explorers and others. The plants grown from these all produced small fruits, none of them being more than an inch in diameter. All these early introductions were made by means of seeds, and all produced seedling types of fruit, most of them being little more than skin and stone.

With the establishment of the large-fruited varieties from the scions sent in by Meyer in 1908 and subsequent years, the interest in this fruit has been renewed. A total of 68 introductions were made by him.

The seedling types attracted little or no attention as a commercial fruit, but, with the bearing of the larger fruited varieties, many horticulturists and others who have grown them see for the jujube a future as a commercial fruit and also for the home orchard in the drier sections of the Southern and Western States.

BOTANICAL RELATIONSHIPS OF THE JUJUBE.

The jujube belongs to the buckthorn family (Rhamnaceæ) and to the genus Ziziphus Mill. (Zizyphus Adans.), which derives its name from the Arabian word Zizouf, the name for one of the members of this genus, which comprises about 50 species widely distributed through temperate and tropical regions.

In the genus Ziziphus the plants are shrubs or small trees, the branches spiny at the nodes; the leaves alternate, 3-nerved, in the

FIG. 1.—Portion of a deciduous branch of the jujube, showing the axillary cymes of small greenish flowers.

axils of the spines; flowers small, in axillary clusters, greenish; the sepals five, triangular, keeled on the upper side; petals 5, hoodlike, at first surrounding the 5 opposite stamens with which they are inserted on a yellowish disk; ovary sunk in the disk, 2 or 3 celled, terminating in 2 to 6 styles with terminal or lateral stigmatic surfaces; fruit a drupe, fleshy, with a horny stone; seeds 1 to 3, with thin coats.

Of all the species of Ziziphus, by far the most important horticulturally is the Chinese jujube, of which a short description follows.

ZIZIPHUS JUJUBA Mill., 1768, Gard. Dict., ed. 8, I.
Rhamnus zizyphus L., 1753, Sp. Pl. 194.
Z. sativa Gaertn., 1788, Fruct. I, 202.
Z. vulgaris Lam., 1789, Encycl. Meth. Bot. III, 316.
Z. sinensis Lam., 1789, Encycl. Meth. Bot. III, 317.

A shrub or tree 20 to 40 feet high (Pl. I); branches zigzag; spines in pairs, straight, or slightly curved; leaves arising from the axils of the spines, 1½ to 3 inches long and about 1 inch broad, thin, slightly toothed on the margins, borne on short leafstalks; flowers on the lateral branches, 2 to 10 in a cluster, on very short stalks, small, yellowish green; fruit oval, about the size of a plum, of sweetish taste; stone oblong, sharply pointed.

The bark on the trunks of older trees is dark gray with rather narrow, somewhat stratified ridges and deep furrows. The ridges are broken up by horizontal cross fissures at frequent intervals. On the older branches the ridges are broad and flat, while on the younger ones the bark is smooth, reddish brown in color, with a distinct bloom.

Many of the cultivated varieties have spines when young but lose them with age; when present, the spines may be 1¼ inches long. There may be one or more deciduous branches at each node; on these are usually borne the leaves and fruit. These slender branches with their regularly arranged leaves are sometimes mistaken for compound leaves. Morphologically these are branches, as is evidenced by the production of flowers in the axils of the leaves (fig. 1). As the woody branches become older there is a gradual building up of tissue at each node, and the number of deciduous branches arising from a given node increases until there may be as many as 10 produced each year instead of one. (Fig. 2.)

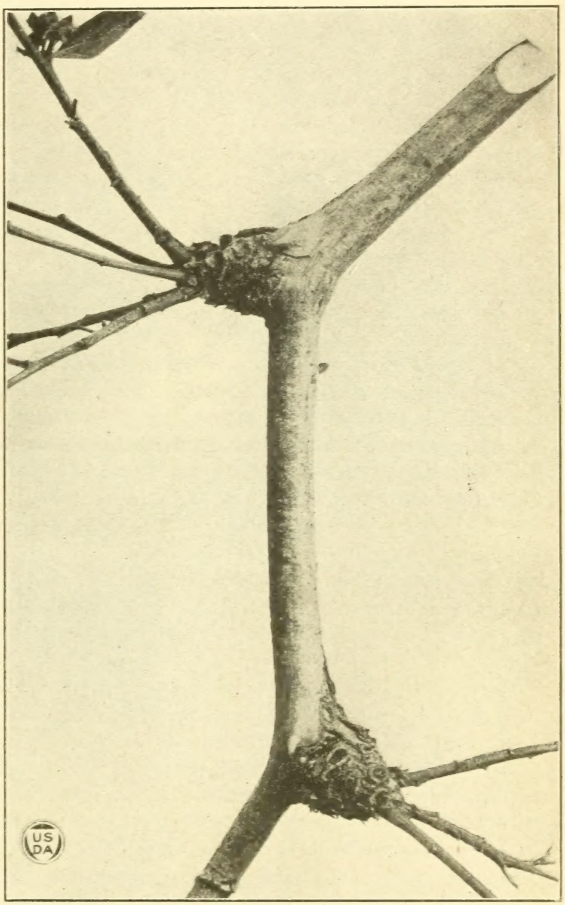

FIG. 2.—Portion of a lateral branch of the jujube, showing the origin of the deciduous branches at the nodes. The number of deciduous branches increases with age.

The peculiar habit of the jujube of shedding its young branches gives the tree an open appearance which, with the rather short re-

curved woody branches and gray bark, makes the tree distinctly ornamental, even during the winter season.

Sometimes branches are found more or less intermediate between the deciduous and woody ones. Such branches bear leaves and fruit. In some cases young grafted plants have branches of this kind only. They are then spreading in habit instead of upright. At the end of the season, branches of this type usually die back about half, while the remaining portion hardens and the following year puts out new leaves. Some of the lower buds on such branches may develop into woody branches the next season.

The leaves vary from ovate to ovate-lanceolate, with oblique, heart-shaped bases, and they are prominently 3-ribbed, smooth and lustrous green above, somewhat paler below, very ornamental.

When the flower opens, the anthers are fitted into the hoods of the petals, from which they are released and their pollen shed the first day. The stigmas remain closely appressed by their inner surfaces until the second day, when the upper portions of the styles recurve, thus placing the stigmas in position to receive pollen. The disk exudes nectar after the stigmas are in position, so that insects are attracted and cross-fertilization is assured.

The mature fruit varies greatly in size and shape. It may be spherical and not more than one-half to 1 inch in diameter, consisting of little more than skin and stone, or it may be ovoid, ellipsoidal, or pear-shaped and 2 inches in diameter. The fruit (Pls. II–V) has a curious method of ripening. Brown spots appear here and there on the green fruit and gradually increase in size until they merge and completely cover the surface. The fruit at this time is a beautiful golden brown; within a few days it begins to dry, then wrinkles (Pl. II), and becomes darker. If left on the tree until completely dried, it turns to a rich mahogany brown. The stone varies in size and shape, in some varieties closely resembling a cherry pit, in others being ellipsoidal with a sharp spine at one end. In some forms the stone is almost smooth, while in others it is furrowed and ridged.

Besides the Chinese jujube, quite a number of others have become important in cultivation, and several of these are native to the United States and adjacent portions of Mexico. Any or all of them may sooner or later spring into prominence in jujube culture, either as improved fruits or as stocks. It is therefore not amiss to describe some of these species in such detail that they may be recognized. Some, though not all, of the synonymy of their scientific names is given, in order to assist in keeping clear the matter of species and varieties in a genus where much nomenclatorial confusion and duplication have existed.

ZIZIPHUS MAURITIANA Lam., 1789, Encycl. Meth. Bot. III, 319.
Z. jujuba Lam., 1789, Encycl. Meth. Bot. III, 318; not Mill.
Z. orthacantha, DC., 1825, Prodr. II, 21.
Z. rotundata, DC., 1825, Prodr. II, 21.

A tall shrub or small tree with short prickles (rarely none) and ovate or nearly round leaves, usually very obtuse, three-fourths to 1½ inches long, smooth above, the under surface as well as the leafstalks and young branches covered with a close white or rusty wool. Flower clusters small, compact, and closely seated on the branches. Fruit globose (Pl. VIII) one-half to 1 inch in diameter, dark red.

This, the so-called Indian jujube, has usually passed under the name of *Ziziphus jujuba*, but that name should be retained for the Chinese jujube, which in the past has generally been called *Ziziphus vulgaris* and *Z. sativa*. The Indian jujube is native to British India, southwestern China, and perhaps also to parts of the Malay Peninsula. There are three Sanskrit names for it, and its cultivation in India dates from ancient times. It has now been introduced into the East Indies, Australia, and the Mediterranean region. In

FIG. 3.—*Ziziphus lycioides*. This American relative of the jujube is found in semi-arid situations in the southwestern United States. The long thorns, which are modified branches, have lateral branches bearing leaves and flowers. The thorns in *Z. jujuba* are stipular in origin; hence do not produce branches.

Egypt it is called 'ennab. On the island of Mauritius a large number of horticultural varieties have been evolved. The species tolerates even a warmer climate than does the Chinese jujube. The fruit is quite acid in flavor and should prove of value as a tart fruit in the warmer sections of Florida. It has been introduced by the Department of Agriculture into southern Florida, where there are a number of trees in bearing. The fruits vary in quality, some of them being delicious, others developing butyric acid in the process of ripening. This species is a positive acquisition to Florida horticulture. It will prove a desirable fruit for dooryards because of its unfailing habit of fruiting.

ZIZIPHUS OBTUSIFOLIA Gray, 1849, Genera Flor. Illustr. II, 170.
Rhamnus obtusifolia Hooker, 1840, ex. T. & G. Fl. N. A. I, 685.

A somewhat thorny, smooth shrub with whitish branches and leaves ovate or oblong-ovate, obscurely toothed or sometimes with distant, rather conspicuous teeth, shining above, varying from 1 to 2 inches in length and one-half to 1 inch in width, the bases characteristically broad and straight, giving the leaf a triangular outline; flowers in compact clusters; fruit subglobose, small, black. This is a native of dry plains in Texas; called lote bush or Texas buckthorn.

ZIZIPHUS LYCIOIDES A. Gray, 1850, Bost. Jour. Nat. Hist. VI.

Closely similar to the preceding, except that the leaves average smaller, and instead of being truncated at the base they taper gradually to the leafstalk, the margins wholly or almost entire, in mature specimens hairy at the base and on the leafstalk; the long straight leafy thorns abundant (fig. 3); flower stalk and calyx soft hairy.

The fruit is small and not very palatable, but the species may be of value as a stock in certain sections. It is native to the Southwestern States. The variety *canescens* A. Gray has the branches, thorns, and leaves covered with a whitish or even pinkish bloom, similar to that often seen on stonecrop (Sedum), and the whole shrub is somewhat thornier, with smaller leaves. It is a variety found in the drier situations.

ZIZIPHUS PARRYI Torr., 1859, Rep. U. S. & Mex. Bound. Surv. Bot. II, Part 1, 46.

A shrub 4 to 6 feet high, much branched, the branches smooth, flexuous, armed with numerous slender, leafy spines; leaves two-thirds to 1 inch long, obtuse, abruptly tapering to a short leafstalk. Fruits one-half to two-thirds of an inch long, with an abrupt point, lemon yellow, the pulp very thin; nut shell extremely thick and hard; seeds narrowly oblong. This plant, a native of southern California, has a nearly dry, 3-celled fruit and extremely thick shell.

ZIZIPHUS SONORENSIS S. Wats., 1889, Proc. Amer. Acad., new ser. xvi, 44.

A shrub 5 to 8 feet high with smooth grayish bark and compact top; short rigid branches, very thorny; leaves nearly smooth, thin, ovate to ovate-elliptic, obtuse, slightly heart-shaped or wedge-shaped at base, almost or wholly entire on the margins, 1 to 2 inches long; fruit subglobose, reddish brown when ripe, about half an inch long, edible. This species is common in northern Mexico, frequently in brackish water, and for that reason it may prove of value as a stock in regions distinctly alkaline.

VARIETIES.

A great many introductions of the Chinese jujube have been made by the Department of Agriculture in the last 25 years, most of them by means of seeds. Meyer succeeded in getting scions of several different varieties. Most of these were successfully propagated upon their arrival in the United States, and it is from these that the best and largest fruited varieties have been secured.

Some of these varieties resemble others very closely in size, shape, and quality, and so far as our present information is concerned have no outstanding merit. In some cases the size or shape of the fruit is such as to render it undesirable; in others the shape of the stone is objectionable. After considering the desirable qualities of all the varieties, four have been selected as being distinctly superior to any of the others.

It seems best to limit the distribution to these four varieties for the present, since they have all the desirable characters to be found in the varieties we now have and are the largest. If future investigation reveals superior qualities in some of the undescribed varieties, they can then be described, propagated, and distributed.

GENERAL APPEARANCE AND HABIT OF THE JUJUBE TREE.

As a rule the jujube is a heavy bearer, and the contrast of the smooth, dark-brown fruits with the glossy green foliage makes the tree decidedly ornamental. The specimen here shown is 12 years old and about 20 feet in height. The drooping of the branches is caused by the heavy load of fruit. (Photographed by P. H. Dorsett, Plant Introduction Garden, Chico, Calif., October 12, 1921; P27376FS.)

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THE MU SHING HONG JUJUBE.

The Chinese, by patient selection carried on throughout many generations, have developed a number of distinct jujube varieties, and a few of these appear particularly well adapted to conditions in California and the Southwest. One of these is the Mu Shing Hong (S. P. I. No. 22684), which is of excellent shape and size for processing. The fruits average 30 to 35 to the pound. (Photographed by P. H. Dorsett, Plant Introduction Garden, Chico, Calif., October 17, 1918; P20919FS; about half natural size.)

THE LANG JUJUBE.

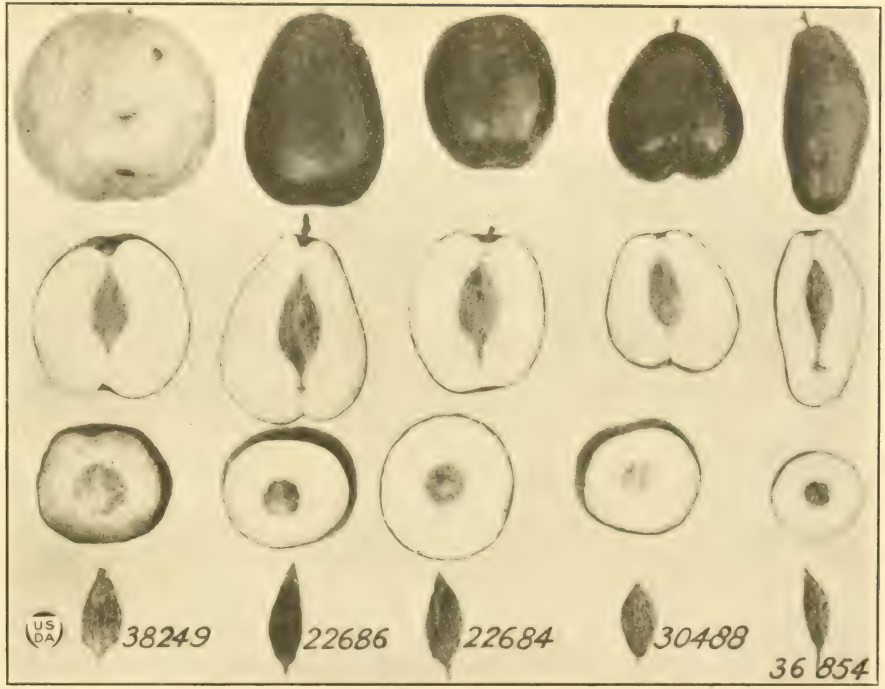
Of the four varieties considered most promising for cultivation in the United States, the Lang (S. P. I. No. 22586) is the most easily propagated. At the same time the tree is a good bearer and the large, pear-shaped fruits, which average 25 to 30 to the pound, are very satisfactory for processing. (Photographed by P. H. Dorsett, Plant Introduction Garden, Chico, Calif., October 11, 1917: P20912FS: about half natural size.)

THE SUI MEN JUJUBE.

The Sui Men (S. P. I. No. 38245) is in most of its characteristics very much like the Mu Shing Hong, but it bears a heavier crop. The fruits, which average 30 to 35 to the pound, are usually ellipsoidal in shape. (Photographed by P. H. Dorsett, Plant Introduction Garden, Chico, Calif., October 28, 1918; P24709FS; about half natural size.)

THE LI JUJUBE.

The fruits of the Li (S. P. I. No. 38249) are the largest of any variety introduced into the United States, often reaching a diameter of 2 inches, and averaging 12 to 18 to the pound. The flesh is crisp, making it suitable for eating out of hand, and the pit, in proportion to the flesh, is the smallest of any variety examined. The Li is also excellent for processing. The ripening season is one or two weeks later than that of other varieties. (Photographed by P. H. Dorsett, Plant Introduction Garden, Chico, Calif., September 23, 1921; P27311FS; about half natural size.)



WHOLE AND SECTIONED FRUITS OF FIVE LARGER VARIETIES.

The different varieties of jujubes vary considerably in size and shape and in the relative proportion of flesh to pit. The first three of the varieties here shown are fully described in the text. (Photographed by P. H. Dorsett, Plant Introduction Garden, Chico, Calif., September 23, 1921; P28154FS; about half natural size.)

INTRODUCED VARIETIES OF THE JUJUBE.

These five varieties are smaller fruited than some which have been secured from China, but they have been distributed by the department and are cultivated in a number of American gardens. The second variety (S. P. I. No. 38245) is the only one of the five which is described in this bulletin. (Photographed by P. H. Dorsett, Plant Introduction Garden, Chico, Calif., September 23, 1921; P27309FS; about half natural size.)

THE INDIAN JUJUBE (ZIZIPHUS MAURITIANA LAM.; S. P. I. NO. 45638).

This species has been grown since ancient times in southern Asia, but up to the present no varieties of any considerable size have been secured by the department. The fruits resemble small crab apples in shape. They have flesh of plumlike flavor, and the species should be of great value as a tart fruit for the warmer parts of Florida, where a number of trees are already in bearing. (Photographed by E. L. Crandall, Washington, D. C., February 7, 1922; P27245FS; about half natural size.)

The color of the fruit has not been discussed in these descriptions because it is not sufficiently distinct to be a varietal character. It varies at different stages of maturity: it first appears as reddish brown spots on the green fruit; these increase in size and finally merge. The color of the fruit becomes the most intense when these spots have all united; it is then a dark chestnut brown. In the Mu Shing Hong variety (Pl. II) it is beautifully mottled. The fruit loses water and begins to wrinkle within a very few days after it has become fully colored. During this drying-out process the color changes and the dried fruit assumes a reddish brown that is less intense than that present when it first begins to ripen.

The fleshy portion of the jujube fruit is drier than that of our common fruits. It does not vary sufficiently to become a varietal character. The flesh of the Li variety (Pl. V) is more crisp than that of the other three varieties, and not quite so dry.

The varietal names are those sent in by Meyer in his notes, which were made at the time the scions were secured. In the Chinese literature a large number of varietal names and descriptions appear. These have been brought together by W. T. Swingle, of the United States Department of Agriculture. Meyer found some of these in his field investigations, but the most of them remain yet to be studied in the orchards of China.

The date of ripening varies greatly. In some portions of Texas and California the fruit begins to ripen early in August, while in others it does not begin to ripen until the first or middle of September. The ripening period in a given locality continues for six or eight weeks, beginning with the fruit on the old wood and ending with that on the growth of the present year.

All varieties of the jujube come into bearing at an early age. Frequently the young plants in a nursery row at less than one year bear fruit, and the second or third year after planting they yield abundantly.

MU SHING HONG, S. P. I. NO. 22684.[2]

This is an excellent variety (Pl. II). The fruit is of good size and shape and processes well. While trees of this variety do not bear as abundantly as some of the others, the fruit is very handsome and can be utilized in many ways.

Source.—Tsingtze, Shansi Province, China. Scions secured by Frank N. Meyer, March 10, 1908. *Size* large, 1⅛ to 1⅝ inches in greatest diameter; *form* ellipsoidal, somewhat flattened at the ends, some fruits irregular; *cavity* regular, of medium depth, distinct areole about the cavity one-eighth of an inch from the insertion of the peduncle; *basin* regular, smooth and shallow; *stone* ellipsoidal, medium sized to large, three-fourths to 1¼ inches in length, three-eighths to 1½ inches greatest diameter. In some fruits of this variety the usually bony portion of the stone does not harden, thus giving rise to what are termed seedless fruits. The stone has a strong acute tip at the distal end.

LANG, S. P. I. NO. 22686.

This is one of the very best varieties (Pl. III). It has a large pear-shaped fruit, which processes well. It produces an abundance of fruit and is one of the most readily propagated of all the varieties.

[2] Serial number assigned by the Office of Foreign Seed and Plant Introduction.

Source.—Tsingtze, Shansi Province, China. Scions secured by Frank N. Meyer, March 10, 1908. *Size* large, 1½ to 2 inches in length, 1 to 1½ inches greatest diameter; *form* obovoid to pyriform, some obliquely so, one side being more rounded and full; *cavity* regular, very shallow up to the areole, then abruptly conical; *basin* of medium depth, becoming more or less wrinkled and irregular in dried fruit; *stone* ellipsoid, medium sized, seven-eighths to 1⅛ inches in length, one-half to three-fourths inch greatest diameter, tapering more abruptly toward the distal end, which terminates in a sharp stout spine.

SUI MEN, S. P. I. NO. 38245.

This variety is of average size, processes well, and has a good shape (Pl. IV). A good variety for all purposes.

Source.—Near Paihsiangchen, Shansi Province, China. Scions secured by Frank N. Meyer, February 13, 1914. *Size* medium, 1 to 1¾ inches in length, seven-eighths to 1½ inches greatest diameter; *form* ellipsoidal, some fruits unsymmetrical; *cavity* practically none except within the areole, which is about one-eighth inch from the insertion of the peduncle; *basin* of medium depth, regular in some fruits, irregular when dried, becoming longer in one direction than the other; *stone* large, three-fourths to 1⅛ inches in length, one-fourth to three-eighths inch greatest diameter, ellipsoidal, widest near distal end, which is terminated by a short sharp spine.

LI, S. P. I. NO. 38249.

Of all the varieties introduced, this one (Pl. V) has the largest fruit, is one of the best to eat as it comes from the tree, and ripens the latest by one to two weeks. Its flesh is crisp; it processes well, and of all the varieties analyzed it has the smallest pit in proportion to flesh.

Source.—Fuma, Shansi Province, China. Scions secured by Frank N. Meyer, February 14, 1914. *Size* large; Meyer's note says, "supposed to be the largest of all," 1¾ to 2 inches in length, 1 to 2 inches in greatest diameter; *form* spherical-ovoid, somewhat flattened at the ends, some fruits irregular; *cavity* furrowed, of average depth or slightly deeper; *basin* deep, irregular, longer in one direction than the other; *stone* large, three-fourths to 1 inch in length, three-eighths to one-half inch greatest diameter, ovoid, tapering more abruptly toward the distal end, which terminates in a short thick spine.

OTHER VARIETIES.

Not only the four varieties here described but a number of others have been distributed by the Department of Agriculture. These are not sufficiently different to justify detailed descriptions of them here; their size, shape, and other characteristics are shown in Plates VI and VII. These illustrations will enable persons to identify any of the varieties represented.

The fruit of S. P. I. No. 30488 is, in outline, shaped like an inverted heart. This variety is a good producer and is free from spines. S. P. I. No. 36854 has an elongated fruit that tapers toward both ends. This fruit is well flavored and has a high sugar content, but the stone terminates in a long sharp point which is easily broken off when the fruit is eaten. S. P. I. Nos. 38243 and 38246 are very much like No. 38245 in size, shape, season of ripening, and productivity. S. P. I. Nos. 37475 and 37476 have fruits that are more or less spherical, but with the ends flattened. These two numbers are practically identical. The stone is short, with the distal end protruding but slightly.

Mention should be made of the seedless varieties. Meyer's notes refer to S. P. I. No. 35253 as being seedless, but the fruits produced in this country by this number have had seeds. The Mu Shing Hong variety (S. P. I. No. 22684) produces a small percentage of seedless fruits on the trees growing in the Plant Introduction Garden at Chico, Calif., in addition to the large number of fruits bearing normal seeds.

PROPAGATION.

The jujube may be propagated by means of seeds,[3] cuttings, buds, and grafts.

SEEDS.

Plants secured from seeds bear small fruits, most of which are little more than skin and seed, and are of value chiefly as stocks upon which to graft the large-fruited varieties. The seeds of the large-fruited varieties show a low percentage of germination, whereas those of the small-fruited seedlings show a germination varying from 25 to 95 per cent.

As soon as the fruit is ripe it should be gathered, placed in a water-tight container, and covered with water; or it should be buried in wet soil. After a week or 10 days the pulp will have fermented and decayed sufficiently to make it possible to remove it without difficulty.

The pulp can be removed by using a square-bottomed trough, the bottom of which should be lined for a distance of about 3 feet at one end with a piece of wire screen having about four meshes to the inch. A board slightly narrower than the trough and about 18 inches in length should be covered on one side with wire screen of the same mesh as is used in the trough. A handle should be fitted to the other side, to make the board convenient for this work. The fruit should be placed in the trough and the pulp removed by moving the piece with the handle back and forth over the top with sufficient pressure to break away the pulp. A stream of water should be allowed to run through the trough during this process, large enough to remove the pulp as it is freed from the pit. Removable cross-bars about 2 inches in height should be placed at intervals of 1 foot. The pulp and light empty pits will be carried over, while the pits with viable seeds, being heavier, will lodge between the crosspieces.

After the pulp has been removed, the surplus moisture should be drained from the seeds. They should then be stored and protected from heat and drying, or they can be stratified in sand and kept in a cool, moist place. Three or four weeks before they are to be put in the ground they should be stratified in moist sand in a warm place; if previously stratified they should be moved to a warm place. Where greenhouse space is available and the seeds are to be stratified in large quantities, a layer of sand about 2 inches deep may be spread on a bench having bottom heat. A piece of burlap should then be spread over the sand; this, in turn, should be covered with a very thin layer of sand, on which the seeds are spread in a thin layer, and barely covered with sand. Over this another piece of burlap is spread and covered with about an inch of sand. The sand should be kept moist, but not wet. Where this method is used, it is possible to stratify a

[3] The word "seed" is used for convenience. Technically, this is a 2-celled putamen, having one or two seeds.

large quantity of seeds and still be able to examine them from time to time by lifting one side of the upper piece of burlap.

If smaller quantities of seeds are to be stratified, boxes of suitable size can be used, and put in a warm place. After two or three weeks the seeds should be carefully examined every day or two. As soon as they begin to crack open they should be placed in nursery rows. They should be sown in the row close enough together to form an almost continuous row of seeds, and should be covered with not more than 1½ inches of moist soil. Seeds that have been stratified in sand between strips of burlap can be screened with that sand, leaving the seeds behind, or the sand and the seeds can be drilled in the rows without screening.

The stratified seeds should not be submitted to heat too soon, thus making it necessary to plant them outside before the soil is thoroughly warmed. If cold weather follows after planting them outside, losses will occur, because of the shock occasioned by taking them from the warm sand bed and exposing them to the cold. After planting, the soil should be kept pulverized above the seed to keep it from baking. When the young seedlings first appear, they are rather delicate and are often injured by having to push through a hard crust. The soil can be kept moist and open by covering the rows with a thin layer of straw, rice hulls, or some other mulch. The seeds should not have more than 1 to 1½ inches of soil over them, and care should be exercised not to use too deep a mulch, because if too much is used it will keep the soil cool and thus retard germination.

The seeds can be held over winter and planted without stratification when the soil has been thoroughly warmed in the spring. When planted in this way the percentage of germination will not be as great as when the seeds are carefully stratified and then planted out when the seeds and soil are in the proper condition. The jujube in all stages of its development revels in heat.

Where the quantity of seeds is not too great, they can be planted in beds instead of rows. It is then possible to take better care of them, and a better stand will be secured. When planted in beds it will be necessary to hold most of the plants over until the second year, because only a small percentage will make sufficient growth to be of grafting size the first year. If they are to be planted in this way they should be lined out in rows for the second season, placing them 4 to 6 inches apart. When stratified seeds are planted in rows, 75 to 90 per cent of the seedlings should be large enough for grafting at the end of the first season.

CUTTINGS.

Little or no success has resulted from repeated attempts to root any type of cutting taken from the portion of the plant above ground. When grafted plants are removed from the nursery, a plant will occasionally be found in which the lower end of the scion has taken root.

Cuttings made by clipping the lower ends of the roots from the stock plants of bench grafts have given a good percentage of plants of sufficient size to graft. Pieces of roots 4 to 6 inches in length and having a diameter of not less than three-sixteenths of an inch have produced good plants the first season, and these plants have good

root systems, as shown in Figure 4. By the use of root cuttings the supply of stocks can be increased where seeds are not available. This method might also be employed to increase the supply of large-fruited varieties after they have once been rooted by layering or by the rooting of scions.

BUDDING.

Propagating the jujube by budding has not as yet given very satisfactory results. The wood is very hard and the bark thin, making budding a difficult matter. The results of budding in August or September have been almost entirely negative. Spring budding has been more successful, but the percentage of trees se-

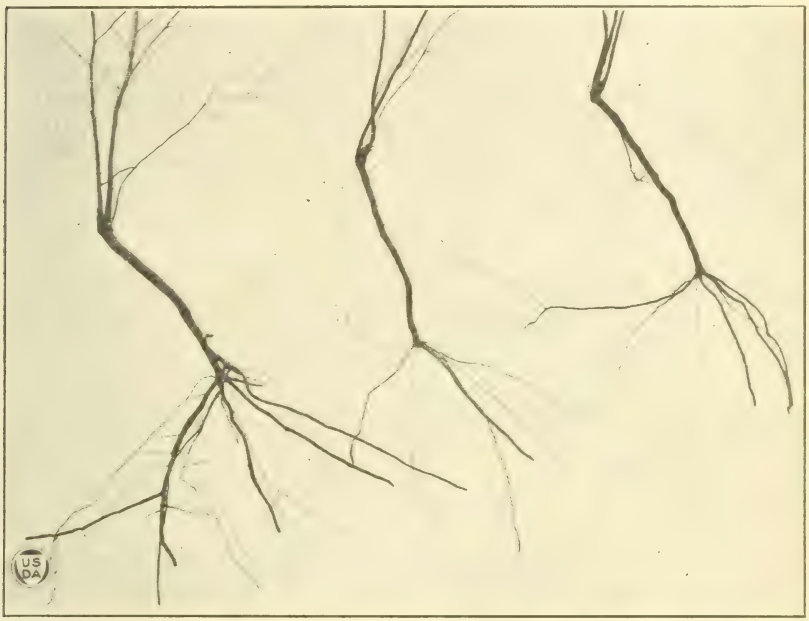


FIG. 4.—One-year-old plants of jujube grown from 4 to 6 inch root cuttings. Root cuttings, made by clipping the lower ends of the roots from the stock plants, have given a good percentage of plants for stock purposes.

cured by this method has been small. For spring budding the budwood should be cut in the dormant season (January or February) and held in a cold place, preferably in cold storage at a temperature above freezing, until the stocks begin to push and are full of sap. The common shield bud is the one generally used. In cutting the bud care must be exercised to avoid breaking it. The growth of the jujube branch is more or less angular, and the bud is so located that it is easily broken when an attempt is made to remove it. If the bud is cut from both above and below there is less danger of breaking. Twig budding has in some instances been reported as successful.

GRAFTING.

The most successful method of propagating the jujube has been by the ordinary whipgraft. Good results have been obtained both

by bench and field grafting. While field grafting is somewhat slower than bench grafting, a better stand is obtained, and when one considers the labor involved in digging the stocks and putting them back into the ground when they are bench-grafted, plants can be secured at less cost per plant by field grafting. Where the plants are to be bench-grafted they can be dug in the fall and heeled in at a convenient place. The scions can be cut at the time the grafting is done. The wood (fig. 5, *a*) used for this work should be the past season's growth. It should not be much smaller than a lead pencil, as smaller wood does not produce suitable plants. The small side

FIG. 5.—Top of a jujube tree which has been cut back, showing new growth, small lateral branches, and spines. *a*, Wood suitable for propagation; *b*, twig too small to be used in propagating; *c*, new branches resulting from cutting back the main branch.

branches (fig. 5, *b*) which bear the leafy deciduous branches are not suitable for scions. The grafting should be done one to two months before the plants are to be put in the nursery. After the graft has been made it should be carefully tied with raffia, waxed, and allowed to callus in damp shingle tow or moss in a place where the temperature is 40° to 50° F. In about three to eight weeks the callusing will have progressed sufficiently to allow the plants to be set out in the nursery. When the weather is suitable the plants should be lined out in nursery rows, and care should be taken to see that the stock and grafts are completely covered with soil. The soil

should be heaped up so that the upper end of the scion is covered 1 to 1½ inches. This will prevent drying out, a precaution absolutely essential to success.

Where the grafting is done in the field the scion wood can be cut at the same time, even though the trees are beginning to grow. The bud that produces the new plant is a dormant one that would not grow under ordinary circumstances, but when the short branch above it is cut off, as is the case in preparing the scion, the bud is forced out when the stock starts to grow. As soon as the stocks begin to push and are full of sap they are ready to be grafted. The whipgraft is used and should be tied with raffia and waxed. The soil should be removed from around the stock, so as to allow sufficient room to make the graft below the surface of the soil. After the graft is made and tied, the soil should be replaced and heaped up sufficiently to cover the scion to a depth of 1 to 1½ inches, as in the case of the bench grafts.

Where large seedling trees several years old are available or where stocks are too large to be successfully grafted by the whipgraft, the cleft-graft has been used. The operation is the same as for other fruits.

CULTURE.

CLIMATE.

The jujube grows vigorously in hot climates and reaches its best development where the weather is dry, the sunshine brilliant, the nights warm, and the summer long and hot. The southwestern section of the United States, with the exception of the elevated portions where the summer nights are too cool and limited areas, such as coastal regions, where the humidity may retard fruit production, is well adapted to jujube culture. The drier sections of some of the Southern States have produced some excellent fruit. The jujube has withstood temperatures of −22° F. without injury (*5*), but growth in regions where the summers are cool is very slow, and the number of fruits produced is few or none, as compared with the rapid growth and abundant and regular fruiting secured where the temperature sometimes reaches 120° F.

Because of its late flowering, the jujube is free from spring frost injury. In regions where the peach, almond, and apricot bloom in February, the jujube does not begin to flower until about May 20, long after danger from frost is over. Those who have lost fruit crops from frost can appreciate the great advantage of a tree that produces a good crop year after year without being injured by late frosts.

Sufficient data are not available to determine the minimum water requirement. The trees do well in Texas without irrigation; they also do well in California both with and without irrigation. During the first few years they require about the same quantity of water as any young deciduous orchard tree under similar conditions. After they have become established they will withstand more drought than other deciduous fruit trees under the same conditions.

It should be remembered that while the jujube will grow and produce a good crop of fruit with a limited supply of water, it will also respond to irrigation by producing more and larger fruits.

SOIL.

The soil requirements of the jujube are not as important as certain climatic conditions. Meyer (*8*) says "They are found equally productive on a piece of strongly alkaline land or in an inner courtyard where the ground has been tramped down until it is as hard as a stone. The soil best suited to this fruit is a porous clay, charged with more or less alkaline matter, like the loess of northern China."

A letter from Prof. J. J. Thornber, Director of the Arizona Agricultural Experiment Station, contains the following statement concerning the soil in which certain jujubes have been successfully grown:

> The soil is a fine, sandy loam, rather deep, and quite alkaline in nature, and they are making a very splendid growth. . . . One other matter with reference to growing these plants I am sure you will be interested in; namely, originally we grew these plants in our introduction garden on the university campus where the soil is shallow, rather heavy, and intensely calcareous but with no alkali. Here they were irrigated once every two weeks during the growing season, and in the three years' time that they grew in the garden I think they grew altogether not more than 6 inches. In other words, they were almost a total failure, although none of them died and they appeared healthy all the time. At first I thought it was their natural habit of growth, but upon transplanting them to the introduction garden at the university farm, where the soil is alkaline, I found they required alkaline soil for the best growth.

The jujube does well also in sections where the soil is not alkaline. It has been observed making a vigorous growth and producing an abundance of fruit on heavy poorly drained soil where peaches and other fruits were unable to maintain themselves. While the jujube grows and produces fruit on rather heavy clay soils, the best results are secured on sandy loams and the lighter soils.

TIME OF PLANTING.

The jujube should be planted at about the same time as other deciduous fruits. The winter season throughout most of the region adapted to jujube culture is mild, and the soil can be worked, except for an occasional overabundance of moisture, during the entire winter. The planting should be done as early as possible in order that the soil may become firmly packed about the roots. The period extending from December through March is a good one, but in some sections March may be a little late, because of the drying winds and decrease in rainfall.

DISTANCE FOR PLANTING.

As a young tree or when allowed to grow without pruning, the jujube has a rather upright habit of growth. It could, therefore, be planted 18 by 18 feet, but the best modern horticultural practice now tends to give all orchard trees more space, and in accord with this tendency it would seem best to plant the jujube trees 20 by 20, or 24 by 24 feet, and then by proper pruning induce a spreading growth.

The holes in which the trees are to be set should be of sufficient depth to allow the young tree to be planted an inch or two deeper than it was in the nursery, as shown by the soil line. This will

allow for the settling of the soil. The hole should be of sufficient width to allow the roots to retain their natural positions; long, straggling roots should be cut back to the same length as the main root system.

PRUNING.

There is little information concerning the proper method of pruning jujubes. Most of the trees that have been planted have received little or no pruning, but have been allowed to assume their natural habit, which is more or less upright. The recommendations given below are from recent observation and for a limited number of trees. They will probably require considerable modification after more experience has been gained.

All the short, recurved side branches should be removed from the young trees as they come from the nursery, and the main stem should be headed back to a height of 24 to 30 inches above the ground. The second year about three or four branches should be selected for the framework of the tree, as with other deciduous fruits, and these should be cut back in order to make the tree spread. Where only one or two branches come out the first year they should be cut back in order to stimulate the development of others the second year and to prevent too much upward growth at the expense of lateral development. Thereafter, branches should be selected in such a way as to fill in and give the tree a good spread and keep it as symmetrical and well balanced as possible. In order to induce the tree to spread, it should be headed back to buds that are on the outside of the branch. When a branch is cut back, either the first or second bud below the cut (fig. 5, *c*) puts out new branches, and where the tree is vigorous both buds may grow.

It is rather difficult to reshape old trees that have never been pruned. They should be cut back rather severely in order to force dormant buds lower down on the tree to send out new branches which can be selected in building up the new framework. Frequently when an old tree is cut back severely the first bud below the cut produces a branch that grows straight up, and little is gained, but a second attempt sometimes overcomes this difficulty, and new branches appear lower down.

The main object in pruning should be to force the tree to spread and form a low flat head, in order to keep the fruit as near the ground as possible, for convenience in picking.

Meyer found that ringing, which in effect is a type of pruning, was practiced in connection with certain varieties in China. His notes on S. P. I. No. 35253 contain the following information:

> It is the custom in the Laoling district to ring the trees every year, just when the fruit is setting, by means of sawing through the bark of the trunk, starting the first ring a few inches above the ground and leaving a space of about three-fourths of an inch between the successive rings. They start the ringing when the trees are 6 or 7 years old and continue it for 20 to 30 years, after which time the tree generally dies and is removed. The reason for this ringing process is the fact that a tree which is ringed produces almost twice as much fruit as an unringed one, although the fruits of the latter are much sweeter.

Thus far no noticeable effect has been produced by ringing this variety in this country.

TILLAGE.

The jujube has been observed making a vigorous growth and producing a good crop of fruit along neglected fence rows and in other places where the weeds and undergrowth were about as high as the trees, but it has also been noted that in places where it is well cared for by cultivation and irrigation the fruits are much larger. Certainly the young trees should be well cared for, in order to get them properly established and give them a good start. No young tree can be planted in dry soil where the annual rainfall is very low and be expected to grow without irrigation and cultivation.

Meyer (*9*) says of the jujube: "It stands more neglect than any other of the Chinese fruits and . . . seems to thrive in dooryards in which the soil is packed down until almost as hard as a brick. It responds, however, to cultivation, and in the district around Paihsiangchen, Shansi, where the largest varieties in all China occur, the orchards of jujubes are well cultivated."

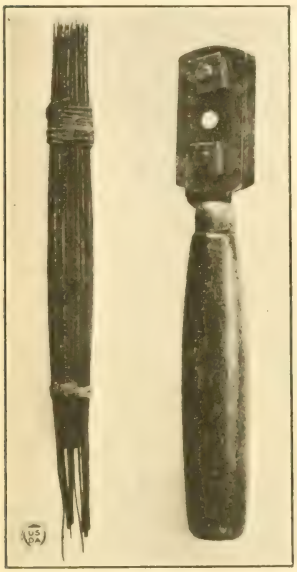


FIG. 6. — Chinese multiple-blade knife (at the left), used for scoring the jujube fruits preparatory to processing; a substitute (at the right) easily made of razor blades.

DISEASES AND INSECTS.

The Chinese jujube is remarkably free from insect pests and plant diseases. Among the thousands of jujube plants propagated and distributed from the Plant Introduction Field Station at Chico, Calif., no insect pests have been discovered, and while a very few plants have been found that had what appeared to be hairy-root, yet a positive identification has never been made, although plants have been sent to the Laboratory of Plant Pathology, Bureau of Plant Industry, United States Department of Agriculture.

Meyer reported a peculiar bunch disease which caused a considerable reduction of the crop in the vicinity of Paihsiangchen, Shansi, China. One or two cases of aphis infestation have been reported late in the fall, in which instances the aphids appeared after other trees had dropped their leaves.

METHODS OF UTILIZING THE CHINESE JUJUBE.

The jujube may be utilized in a number of ways. As regards food value the jujube stands among the first of our fruits, as shown by analysis. It may be utilized as a fresh ripe fruit or in the dried condition. While not as desirable to eat out of hand as some of our other fruits, it is superior to most of them when put up as a confection. It has a flavor that is distinct and pleasing, making the fruit highly desirable. It can be used in many ways in the home. Directions for utilizing the fruit in various ways are given here, and these can be

modified to meet the requirements of persons using them. They are offered chiefly as suggestions.

JUJUBE CONFECTION.

The fruit of the jujube has been used more extensively in this country as a confection than for any other purpose. It is also used in this way in China (*10*), where it is esteemed highly as a gift. To prepare the fruit as a confection it is necessary to cook it in sirup.

The fruit should be punctured or cut in some way before it is put into the sirup. The Chinese score or cut through the skin by using a bundle of small knives. (Fig. 6.) The surface of the entire fruit is scored with this instrument. This permits the sirup to penetrate and gives a plump, attractive appearance to the finished product. (Fig. 7.)

FIG. 7.—Processed jujube fruits, several varieties. Those on the left have been pricked, those on the right scored before processing.

An instrument somewhat similar to this can be made by the use of safety-razor blades. (Fig. 6.) Take an ordinary vegetable knife and with a hack saw shorten the blade to the length of the razor blades to be used. Two small stove bolts, suited to the size of the holes in the blades, can be used to hold the blades in position, after drilling through the blade of the knife two holes of the same size and suitably placed. Small pieces of heavy cardboard about one-eighth of an inch smaller in each direction than the razor blades, with holes punched in them of the same size and the same distance apart as those just mentioned, are used to separate the razor blades. A sufficient number are to be used to keep the blades about one-sixteenth of an inch apart.

An instrument such as this will answer very well for this work, but where the quantity of fruit is too large to be taken care of in this way, or where one does not care to go to the trouble of making such an instrument, various methods of puncturing the fruit

can be used. Where the number of fruits is small, a common table fork will suffice. The fruit is punctured three or four times with the fork as it is turned with the thumb and finger. This will allow the sirup to penetrate as the fruit is cooking. A flat cork in which needles have been placed one-fourth to three-eighths of an inch apart each way, with the points protruding about one-eighth of an inch, can be used in much the same way. The advantage of this instrument over the fork is that it will produce smaller holes and more of them. Where a considerable quantity of fruit is to be processed some kind of a needle board (fig. 8) should be made. This can be done by driving small brads through a piece of thin, even-grained box lumber, preferably from one-fourth to one-half inch in thickness. An area 6 or 8 inches square should be ruled on one side of the board, both lengthwise and crosswise, the lines in each direction being about one-half inch apart. Small wire brads should be driven through the board at the intersections of these lines, the points protruding about one-eighth inch. Strips reaching about one-half inch above the surface should be placed on two sides of the board to prevent the fruit from rolling off. One board can be utilized, the hands being employed to roll the fruit over it, but there will be less danger of pricking the fingers if two boards are made and a handle is put on one of them. The fruit can then be placed on one board and the other used to roll it. Various modifications of these methods can be made to suit individual cases.

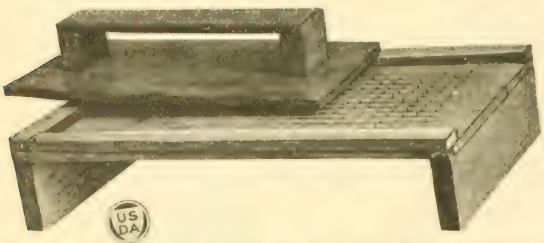


FIG. 8.—A pricking board to be used for perforating jujube fruit before processing.

The fruit to be used in processing may be either fresh or dried. The product of fresh fruit has the milder flavor, although both kinds give excellent results.

If fresh fruit is used it should be picked when the mature brown color has completely overspread the fruit, but before it wrinkles. If dried fruit is to be stored away to be used later in the season it should be allowed to remain on the tree until thoroughly dry before being picked. The fruit will mold if this is not done, or if, after picking, it is not spread out in the sun.

The fruit should be punctured, placed in the sirup, and cooked for 20 to 35 minutes, the time depending on the size of the fruit. It is then allowed to cool in the sirup, after which it is again boiled for the same length of time. It is then taken out and placed on trays for drying, either in the sun or by artificial means. In the early fall three or four days in the sun will suffice to dry the fruit; as the intensity of the heat decreases later in the season, more time will be required. The fruit should be dried until it is firm, but not too hard. If insufficiently dried, when the fruit is placed in the mouth the soft flesh inside separates, leaving the skin. This difficulty will not arise if the fruit is properly dried.

The sirup is made by using one or two parts by volume of sugar to one of water, according to the taste of the individual. The use of the light sirup results in a product having more of the fruit flavor, but if a confection is desired a heavier sirup should be used. If the fruit is to be free from sugar on the outside, the boiling sirup should be made up to its original volume just before the fruit is taken out. The fruit should be well drained as it is removed. Where a sugar coating, as in glacéing, is desired, the original volume should not be renewed, but the fruit should be taken from the concentrated sirup and drained until the surplus sirup runs off, after which it is placed on a tray which has previously been covered with waxed paper. The addition of half a tablespoonful of salt to each quart of sirup is recommended where dried fruit is used. After the fruit has been removed the sirup should be made up to the original volume by adding water. About one-fourth pound of sugar should also be added for each pound of fruit used in the previous cooking. The sirup left after completing the processing makes a very good substitute for maple sirup when used on hot cakes.

In sections where the summers are dry and there is little humidity in the atmosphere the fruit should be stored in containers having tight-fitting covers. Glass fruit jars or tin cans having tight-fitting spring covers can be employed if the fruit is to be held over or used during the summer season.

The fresh fruit as it comes from the tree can be punctured or scored, and after it is thoroughly dried it can be stored away in paper bags. It can then be processed at any subsequent time, as desired. It is easier to puncture or score the fruit when it is fresh and plump than after it is dry and wrinkled.

MISCELLANEOUS RECIPES.

JUJUBE GRAHAM BREAD.

3 cups graham (or whole-wheat) flour.
1 cup white flour.
2 cups thick sour milk.
½ cup sugar.
1 egg.
1 teaspoonful salt.
1½ teaspoonfuls baking powder.
1 teaspoonful soda.
2 cups of dried jujubes cut in small pieces.

Bake one hour in a moderate oven.

JUJUBE CAKE.

1 cup white sugar.
1 cup water.
½ cup lard (not melted).
2 cups dried jujubes cut in small pieces.

Let this come to a good boil, set aside to cool, then add 2 cups wheat flour, 1 teaspoonful soda, ½ teaspoonful salt. Sift these together twice before adding to the above mixture.

Bake in moderate oven.

JUJUBE CAKE FILLING.

2 cups jujubes.
1 cup sugar.
1 cup water.
1 tablespoonful flour.
Juice and grated rind of one good lemon or orange.

Cook the jujubes 20 to 30 minutes; remove skin and seed by rubbing pulp through sieve or colander.

JUJUBE BATTER PUDDING.

½ cup sugar.
1 egg.
½ cup milk.
1 tablespoonful melted butter.
¼ teaspoonful salt.
2 teaspoonfuls baking powder.
1 cup flour.

Put a tablespoonful of this batter into a buttered cup; add a tablespoonful of jujube pulp; cover with a tablespoonful of batter, sprinkle with almonds or shredded coconut, bake half an hour. Serve with hard sauce or cream. Good warmed up.

To prepare jujubes, take one good cup of fruit and cover with water. Cook about 30 minutes; then rub through sieve to remove skin and seeds. Add two teaspoonfuls of orange juice or one of vinegar.

JUJUBE WITH OATMEAL.

1 cup oatmeal.
1 teaspoonful salt.
3 cups boiling water.
1 cup jujubes cut in small pieces.

JUJUBE MOCK MINCE MEAT.

1 pint green tomatoes and 1½ pints jujubes, ground fine in a food chopper.
1½ cups sugar.
½ cup vinegar.
1 teaspoonful cinnamon.
1 teaspoonful nutmeg.
1 teaspoonful cloves.

Cook 30 minutes; then add 1 teaspoonful flour in water (mix thoroughly). Add 1 cup raisins and cook 15 minutes.

JUJUBE SWEET PICKLES.

The fruit should be prepared by dipping in boiling lye water about three minutes or until the skin slips off readily. The lye water should be made in the proportions of 1½ ounces (3 tablespoonfuls) of lye to each quart of water. The fruit should be removed from the boiling lye and plunged into cold running water. It should be washed about five minutes and then boiled in alum water about five minutes. This should be made by using 1½ teaspoonfuls of alum to each 2 quarts of water. The fruit when removed from this should again be washed in running water 5 to 10 minutes, after which it should be removed and well drained. The fruit should then be placed in a sirup made in the following proportions:

3 cups sugar.
1 cup vinegar.
½ cup water.
1 teaspoonful cinnamon.
½ teaspoonful cloves.

Cook fruit until done, skim out, and put back when sirup is boiled down. The above is sufficient for 1 quart of pickles. The fruit should be placed in jars and sealed while hot.

JUJUBE BUTTER.

The fruit should be boiled until tender in sufficient water to cover it. It should then be rubbed through a sieve or colander to remove the skin and seeds.

6 pints jujube pulp.
5 pints sugar.
2 teaspoonfuls cinnamon.
1 teaspoonful nutmeg.
½ teaspoonful cloves.
1 lemon.
¼ pint vinegar.

Cook slowly until thick, put in jars, and seal while hot.

FUTURE OF THE CHINESE JUJUBE.

The Chinese jujube is a plant which will give to the drier sections of the South and Southwest a valuable and highly nutritious fruit of excellent flavor. To the American people this jujube, so long known in Asia, is at present little more than a name, but when it comes to be

properly appreciated as a delicious fruit and a sure crop for sections where ordinarily little fruit is grown, it will become a valuable asset to these regions.

Until adequate machinery and methods for the commercial processing of this fruit are devised, it will have a limited market, and it would be inadvisable for any orchardist or farmer to invest large capital or to plant much of an acreage in jujubes.

The immediate future of the jujube is in its culture as a home fruit. As such it will appeal not only to the farmer, but to the growers and residents generally in the drier States. Throughout this section a few jujube trees can well be planted in every home orchard, thus contributing to the variety of fruits by adding one that is highly nutritious, delicately flavored, and an abundant and sure producer.

COMPOSITION OF THE CHINESE JUJUBE.

By C. G. Church, *Assistant Chemist, Laboratory of Fruit and Vegetable Chemistry, Bureau of Chemistry.*

In view of the interest aroused by the successful propagation and distribution of the Chinese jujube by the Bureau of Plant Industry, it seemed desirable that a study of the general composition of this fruit be undertaken. No such data concerning fruit grown in the United States appeared to be available.

For this purpose samples of fruit at different stages of maturity were supplied by the United States Plant Introduction Garden at Chico, Calif., and the results of the analysis of these samples are tabulated and discussed in the following pages.

SAMPLES EXAMINED.

The samples usually reached the laboratory two or three days after being picked. In some cases it was impossible to handle them as soon as they were received, and such samples were held in cool storage (4° C.) until they were analyzed, the time varying from one to nine days. The effect of storage at this temperature upon the composition of the fruit is difficult to estimate, but there seems to be no great loss of sucrose under these conditions. It is possible that enzymic activity continues and changes the proportions of the different sugars, but it is doubtful whether the total sugars are affected or any of the other constituents undergo appreciable change.

METHODS OF ANALYSIS.

The methods of analysis used were those prescribed by the Association of Official Agricultural Chemists[4] for foods and feeding stuffs, with one or two variations, as follows:

Moisture.—Official method, drying at 70° C. in vacuo. Quartz sand was omitted, as the residue was used for crude-fiber determinations.

Sugars.—The sample was extracted with hot water, to which had been added a few drops of concentrated ammonia to neutralize the acidity and prevent inversion of the sucrose. After the usual clarifications, the cuprous oxid was precipitated, according to the Munson and Walker method, and subsequently determined by the official volumetric permanganate method.

Acidity.—The sample was boiled for 30 minutes in 200 c. c. of distilled water and allowed to stand over night. The resulting extract was titrated against standard alkali, phenolphthalein being used as an indicator.

Protein.—Nitrogen was determined by the official Gunning method and the result was multiplied by 6.25.

Ether extract.—Official direct method.

Crude fiber.—Official method.

Ash.—Official method.

Pectin.[5]—The determination was made by the usual double alcoholic precipitation method.

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[4] Association of Official Agricultural Chemists. Official tentative methods of analysis, as compiled by the Committee on Revision of Methods. Revised to November 1, 1919. 417 p., 18 fig. Washington, D. C. 1920.

[5] H. D. Poore made the pectin determinations.

RESULTS OF ANALYSES.

Table 1 gives the analytical data obtained from the analyses of the raw and the dried fruit on the original basis and calculated to a water-free basis for better comparison. The S. P. I. numbers indicate the varieties as shown in Plate V.

The analytical data obtained on different pickings from the same variety are arranged together and in the order of their picking, so that the changes taking place in the composition of the fruit while it is maturing are readily seen.

The last samples received (Nos. 11, 12, 13, and 14) were picked from the ground, where they had fallen after drying on the tree. The fact that the fruit was dried is shown by the decreased weight of the whole fruit and the decreased percentage of flesh. This marked drying is also indicated in the chemical composition by reduced moisture and increased solids. Even in the earlier pickings more or less shriveling of the fruit was observed.

Of the undried fruits, sample 10 (S. P. I. No. 38249) was the largest, weighing almost 18 grams, or three-fifths ounce, and sample 3 (S. P. I. No. 36854) was the smallest, weighing 5.8 grams, or one-fifth ounce. The weight of the dried fruits ranged from 2.8 grams (one-tenth ounce) to 7.65 grams (one-fourth ounce).

One of the desirable features of the jujube is its large proportion of flesh. In the freshly picked fruit it is never less than 91 per cent, and in several samples it is more than 95 per cent. Even in the dried fruit the minimum is about 85 per cent.

The data in Table 1 show that the sugars are present in large quantities and are no doubt the most valuable food constituent of the jujube. The proportions of reducing sugars and sucrose vary markedly, but this variation is most pronounced in the four samples of S. P. I. No. 22684. In one of these (sample 8) there was no sucrose and in another (sample 12) only 3.03 per cent, the invert-sugar content being high in both cases. On the other hand, the first picking of this variety (sample 5) contained 19.83 per cent of sucrose and the last (sample 13) 39.41 per cent, the invert-sugar content in both cases being also comparatively high. These variations of invert sugar and sucrose are difficult to explain, as there is no definite trend. It is possible, however, that they represent seasonal changes characteristic of this variety.

The percentage of pectin was also low. None of the four samples examined contained more than 1.81 per cent, the lowest content being a trifle over 0.5 per cent. These data, though limited, appear to indicate a decrease in the pectin content as the fruit matures.

Apparently most of the crude fiber of the jujube is contained in the skin. Although present in a comparatively high proportion, this constituent does not affect the eating quality to an appreciable extent. The range on the water-free basis is from 2.25 per cent in S. P. I. No. 38249 to 5.31 per cent in sample 1 of S. P. I. No. 22686. In two (S. P. I. Nos. 22686 and 36854) out of the four varieties which were sampled more than once, the fiber content decreased as the season advanced, and in one other (S. P. I. No. 30488) there was practically no variation. In the fourth variety (S. P. I. No. 22684) it first increased and then decreased, showing no definite tendency.

TABLE 1.—*Composition of jujubes picked at different stages of maturity.*

Variety (S. P. I. No.).	Sample No.	Date picked.	Description.	Weight of fruit (grams).	Proportion (per cent).	
					Flesh.	Pits.
		1921.				
22686	1	Sept. 17	About 50 per cent colored, few shriveled and split, less mature than sample 2.	13.46	95.34	4.66
	2	Sept. 17	Fully colored, 50 per cent shriveled	13.21	95.30	4.70
	[1] 11	Dec. 3	Fully colored, shriveled	4.12	88.37	11.62
22684	5	Oct. 3	Fully colored, 50 per cent shriveled	14.14	93.30	6.24
	8	Oct. 13	Fully colored, all shriveled more or less	10.72	91.37	7.91
	[1] 12	Dec. 3	Fully colored, shriveled	5.43	84.95	15.04
	[2] 13	Dec. 3	Fully colored, shriveled less than sample 12.	7.65	89.23	10.76
36854	3	Sept. 27	About 75 per cent colored, firm and no shriveling, less mature than sample 4.	5.80	93.40	6.60
	4	Sept. 27	Fully colored, few shriveled	5.90	93.30	6.70
	[1] 14	Dec. 3	Fully colored, shriveled	2.80	86.90	13.10
30488	6	Oct. 3	Fully colored, partly wrinkled and soft	10.32	93.78	5.77
	9	Oct. 13	Partially colored, partly wrinkled and soft	10.48	93.75	5.95
36852	7	Oct. 7	Fully colored, very few shriveled	10.21	95.63	4.18
38249	10	Oct. 13	Fully colored, part firm and part shriveled and soft.	17.80	95.62	4.17

Edible matter, original basis (per cent).

Variety. (S. P. I. No.).	Sample No.	Moisture.	Sugars.			Acid, as anhydrous citric.	Protein (N× 6.25).	Fat (ether extract).	Crude fiber.	Ash.	Pectin.	Undetermined matter.
			Reducing (as invert).	Sucrose.	Total.							
22686	1	72.88	27.12	8.73	8.91	17.64	0.35	1.12	0.30	1.44	0.79	0.49	4.99
	2	63.26	36.74	9.95	14.67	24.62	.54	1.14	.26	1.69	.94	.46	7.09
	[1] 11	11.13	88.87	34.22	29.97	64.19	1.31	5.44	.....	3.60	2.22	.....	12.11
22684	5	60.56	39.44	18.86	7.82	26.68	.54	1.27	.....	1.30	1.02	.....	8.63
	8	64.66	35.34	22.10	0.00	22.10	.51	1.55	.....	1.60	.90	.....	8.68
	[1] 12	18.92	81.08	55.03	2.46	57.49	1.31	3.50	.....	3.55	2.21	.....	13.02
	[2] 13	12.47	87.53	25.87	34.49	60.36	1.30	5.63	.....	3.21	2.92	.....	14.11
36854	3	73.96	26.04	7.98	11.21	19.19	.56	.90	.....	1.13	.80	.32	3.14
	4	69.96	30.04	8.42	13.77	22.19	.47	1.01	.....	1.13	.83	.17	4.24
	[1] 14	22.43	77.57	41.85	16.22	58.07	.67	3.13	.....	2.30	1.94	.....	11.46
30488	6	60.06	39.94	14.18	15.12	29.30	.32	1.09	.....	1.38	.76	.....	7.09
	9	62.51	37.49	11.52	14.21	25.73	.30	1.28	.....	1.28	.74	.....	8.16
36852	7	64.49	35.51	5.92	20.20	26.12	.39	1.07	.....	.87	.97	.....	6.09
38249	10	61.27	38.73	11.50	16.34	27.84	.27	1.23	.....	.87	.76	.....	7.76

Edible matter, moisture-free basis (per cent).

Variety (S. P. I. No.).	Sample No.	Sugars.			Acid, as anhydrous citric.	Protein (N× 6.25).	Fat (ether extract).	Crude fiber.	Ash.	Pectin.	Undetermined matter.
		Reducing (as invert).	Sucrose.	Total.							
22686	1	32.19	32.85	65.04	1.29	4.13	1.11	5.31	2.91	1.81	18.40
	2	27.08	39.93	67.01	1.47	3.10	.71	4.60	2.56	1.25	19.30
	[1] 11	38.50	33.72	72.22	1.48	6.12	.....	4.05	2.50	.....	13.63
22684	5	47.82	19.83	67.65	1.37	3.22	.....	3.30	2.59	.....	21.88
	8	62.54	0.00	62.54	1.44	4.39	.....	4.53	2.55	.....	24.56
	[1] 12	67.87	3.03	70.90	1.62	4.32	.....	4.38	2.73	.....	16.06
	[2] 13	29.56	39.41	68.97	1.49	6.43	.....	3.67	3.34	.....	16.12
36854	3	30.64	43.05	73.69	2.15	3.46	.....	4.34	3.07	1.23	12.06
	4	28.03	45.84	73.87	1.56	3.36	.....	3.76	2.76	.57	14.11
	[1] 14	53.95	20.91	74.86	.83	4.04	.....	2.97	2.50	.....	14.77
30488	6	35.50	37.86	73.36	.80	2.73	.....	3.46	1.90	.....	17.77
	9	30.73	37.90	68.63	.80	3.41	.....	3.41	1.97	.....	21.76
36852	7	16.67	56.89	73.56	1.10	3.01	.....	2.45	2.73	.....	17.15
38249	10	29.69	42.19	71.88	.70	3.18	.....	2.25	1.96	.....	20.04

[1] Dried fruit.

[2] Dried fruit from Indio, Calif.

In two of the other varieties (S. P. I. Nos. 22686 and 36854) the reducing sugars increased with the advance of the season, but the sucrose showed a well-defined decrease in S. P. I. No. 36854. In the only remaining variety of which there was more than one sample (S. P. I. No. 30488), a decrease of reducing sugars occurred, while the sucrose content remained practically stationary. The only series in which the late sample showed a decided increase in total sugars over the earlier ones is S. P. I. No. 22686, in which it was a little more than 7 per cent. In the other cases the increases were only slight, and in one (S. P. I. No. 30488) there was a decrease.

Next to the sugars, protein is the most important constituent of the Chinese jujube. While the proportion is not very great, it is high for fruit. Of the varieties examined, S. P. I. No. 22684 contained the highest percentage of protein (6.43), S. P. I. No. 22686 being a close second, with 6.12 per cent. In every case where more than one picking of the same variety was obtained, the tendency of the protein to increase in the later pickings was well defined, particularly in the dried samples.

The acid in the raw fruit was present only in very small quantities. When calculated to the water-free basis, practically no greater differences in acidity were apparent between samples of the same variety than would occur between duplicates of the same sample. One exception to this is recorded in S. P. I. No. 36854, in which the acid content fell from 2.15 per cent in the first picking to 0.86 per cent in the last picking (dried sample). Different varieties show a decided variation. For example, S. P. I. Nos. 30488, 36852, and 38249 were low in acid, while the rest were comparatively high.

Determinations of fat (ether extract) were made on only two samples. As the percentages in these were practically negligible, it seemed unnecessary to determine this constituent in any of the other samples.

Most of the ash also occurs in the skin, as is usually the case with fruits. The lowest percentage of ash was 1.9 in sample 6 of S. P. I. No. 30488; the highest was 3.34 in sample 13 of S. P. I. No. 22684. In two varieties (S. P. I. Nos. 22686 and 36854) there was a slight diminution of ash with increasing maturity, but in the other two (S. P. I. Nos. 22684 and 30488) the reverse was true. In any event the changes were too small to permit definite conclusions.

The "undetermined matter," the difference between the sum of all the constitutents determined and 100, probably is largely pentoses, hemicelluloses, etc. The figures in Table 1 (original basis) show an apparent increase in the "undetermined matter" with increasing maturity. When calculated to the water-free basis, however, this positive change holds for only two varieties (S. P. I. Nos. 36854 and 30488). In the other two varieties (S. P. I. Nos. 22684 and 22686) the reverse is true; that is, this figure decreases with the advancing season. These differences may be of a varietal character.

Table 2 gives a comparison of the Chinese jujube with other fruits of similar type, the fig and the date. Only data on the composition of the dried date were obtainable, but with the fig it was possible to find data on both the fresh and dried fruit. The figures for the jujube represent the average for the fresh and dried fruit taken from Table 1. The data presented in this table may not be comparable in the strictest sense, owing to the fact that it is im-

possible to tell what methods of analysis and calculation were used on the figs and dates. They are sufficiently comparable, however, to give a general idea of the various constituents of the different fruits.

TABLE 2.—*Composition of the jujube compared with that of the fig and the date.*

Product.	Edible matter (per cent).											
	Original basis.							Moisture-free basis.				
	Total in whole fruit.	Water.	Protein.	Fat (ether extract).	Total sugars.	Ash.	Acid.	Protein.	Fat (ether extract).	Total sugars.	Ash.	Acid.
Fresh jujubes	94.12	65.36	1.16	0.28	24.14	0.85	[1] 0.43	3.35	0.81	69.69	2.45	[1] 1.24
Fresh figs [2]	.....	78.93	1.35	.....	15.55	.58	.....	6.41	.....	73.80	2.75	.....
Dried jujubes	87.38	16.24	4.42	.....	60.03	2.32	[1] 1.15	5.28	.....	71.67	2.77	[1] 1.37
Dried figs [3]	.....	28.78	3.58	1.27	51.43	2.75	[4] .71	5.03	1.78	72.21	3.86	[4] 1.00
Dried dates [3]	85.00	18.51	2.71	.60	62.08	1.83	[4] 1.26	3.33	.74	76.18	2.25	[4] 1.55

[1] Calculated as anhydrous citric acid.
[2] Average of numerous analyses compiled from California Expt. Sta. Rpt., 1892-93, and part of 1894, Table A, opp. p. 228.
[3] J. König (7). Chemie der menschlichen Nahrungs- und Genussmittel, vol. 1, p. 868.
[4] Stated as malic acid.

No great difference in composition exists between the fresh jujubes and the fresh figs. The dried fig has an advantage over the dried jujube and the date in the quantity of edible matter. It has practically 100 per cent, while the jujube and the date contain approximately 85 per cent of edible material.

From the data calculated to a water-free basis, it would appear that the jujube compares very favorably in composition with both the fig and the date. In all of the constituents except fat (ether extract) the jujube and the fig are practically alike. The protein content of the jujube is considerably higher than that of the date. This advantage is partially offset, however, by the higher sugar content of the date. The fat (ether extract) content, the ash content, and the acid content are about the same in the two fruits.

The appearance and texture of the jujube are similar to those of the date, and the flavor of the fresh, dried, or candied fruit is pleasant. When dried or candied the jujube is particularly suggestive of the date. The skin is hard and brittle, and the fruit is easily handled without becoming mushy or staining the hands.

SUMMARY OF ANALYSES.

Fourteen samples of jujubes, representing six varieties at different stages of maturity, were analyzed.

The fruit varied in weight from 5.8 to 17.8 grams (one-fifth to three-fifths ounce) in the undried condition, and from 2.8 to 7.65 grams (one-tenth to one-fourth ounce) when dried. It was characterized by a high proportion of edible matter (95 per cent in the freshly picked or undried and 85 per cent in the dried).

Sugars, which were present in fairly large quantities, particularly in the dried fruit, undoubtedly form the most valuable food constituent of the jujube. The percentages of invert sugar and sucrose

varied to some extent, apparently depending upon variety and time of picking. Little change seemed to take place in the total sugar content during the period of harvesting.

The percentages of protein, considered to be the second most important element, are fairly high for fruit. The protein tended to increase slightly with the advance of the season. Little variation occurred in the titrable acidity during the season. The percentage of fat is negligible, and pectin is present in very small quantities. The crude fiber is not excessive for this type of fruit and does not seriously impair its eating quality. Small differences in ash content are noted between fruit of different varieties, but no great change in the proportion appears to take place with maturity.

The jujube compares very favorably with the fig in point of edible matter, total sugars, acid, and ash. This also holds true for the date except for the protein content, which is considerably lower than that of the jujube. In appearance, texture, and flavor the dried or candied jujube is more like the date than any other fruit, and the greatest demand for it probably will be in these two forms.

LITERATURE CITED.

(1) BROWNE, D. J.
1855. Report on the seeds and cuttings recently introduced into the United States. *In* Rept. Comr. Patents, Agr., 1854, p. x–xxxv.

(2) CANDOLLE, ALPHONSE DE.
1886. Origin of cultivated plants. Ed. 2. viii, 468 p. London. Bibliographical footnotes.

(3) CHISOLM, ROBERT.
1851. Jujube tree. *In* Southern Cultivator, v. 9, p. 143.

(4) 1856. The jujube tree. Condensed correspondence. *In* Rept. Comr. Patents, Agr., 1855, p. 311–312.

(5) FAIRCHILD, DAVID.
1918. The grafted jujube of China. *In* Jour. Heredity, v. 9, p. 3–7, illus.

(6) JAFFA, M. E. and COLBY, GEORGE E.
1893. Analyses of figs and fig soils. Calif. Agr. Exp. Sta. Bul. 102, 8 p.

(7) KÖNIG, J.
1903. Chemie der menschlichen Nahrungs- und Genussmittel. Aufl. 4, bearb. von A. Bömer. Bd. 1, 1535 p. Berlin. Bibliographical footnotes.

(8) MEYER, FRANK N.
1911. Agricultural explorations in the fruit and nut orchards of China. U. S. Dept. Agr., Bur. Plant Indus. Bul. 204, 62 p., 15 fig., 6 pl.

(9) 1916. China a fruitful field for plant exploration. *In* U. S. Dept. Agr. Yearbook, 1915, p. 205–224, fig. 4, pl. 29–36.

(10) MILLER, PHILIP.
1768. The gardeners' dictionary. Ed. 8, [1332] p., front., 19 pl. London.

(11) PLINIUS SECUNDUS, C.
1855. Natural history of Pliny, transl. by John Bostock and H. T. Riley. v. 3, 536 p. London.

(12) REDMOND, D.
1859. Pomological resources of the South. *In* Rept. Comr. Patents, Agr., 1858, p. 377–385.

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